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GB 1497944
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GB 0936147
GB 0817226
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(54) Continuous production of a scratch-resistant coating on plastics mouldings

(57) Apparatus for continuously producing a scratch-resistant coating on thermoplastic mouldings, comprises a chamber which is subdivided into three sections I, II and III, within which an endless conveyor belt (2) is guided so that cycle times are achieved which correspond to the coating and drying times of the coated mouldings. The conveyor belt comprises, in the plane of the belt, laterally projecting retaining elements (3) for the mouldings and the number of retaining elements per unit of belt is adjustable such that the cycle times required are achieved. Section I is designed so that the retaining elements are loaded with the mouldings and the mouldings are then removed after one cycle. In section II is provided an immersion bath (4) which contains the coating composition and is provided with an outlet (6) and inlet (7) for a filter circuit (5), whilst in section III there is a drying mechanism (8).

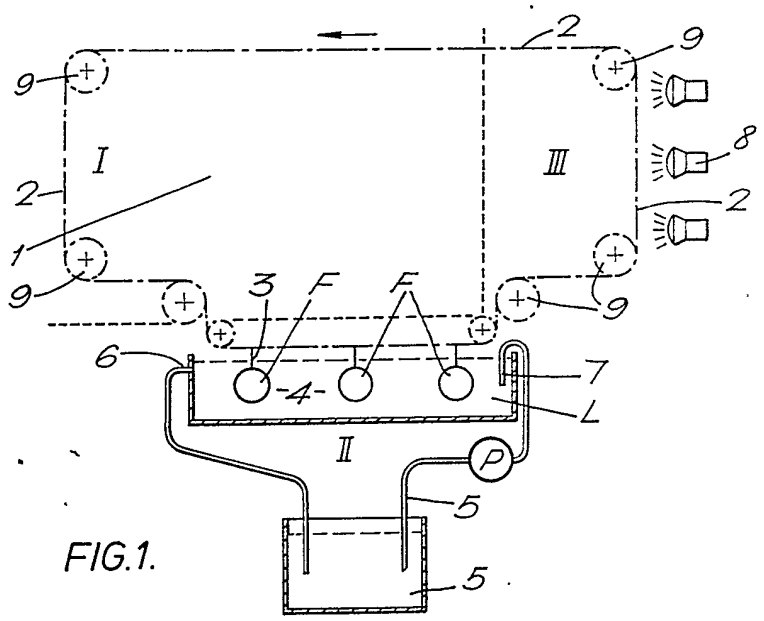

FIG.1.

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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

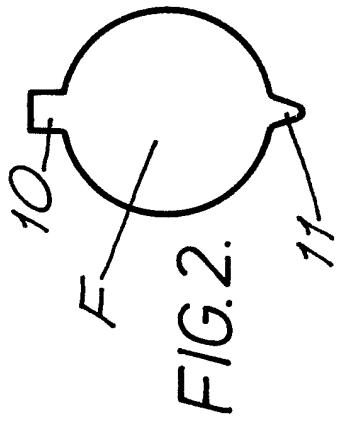

FIG.2.

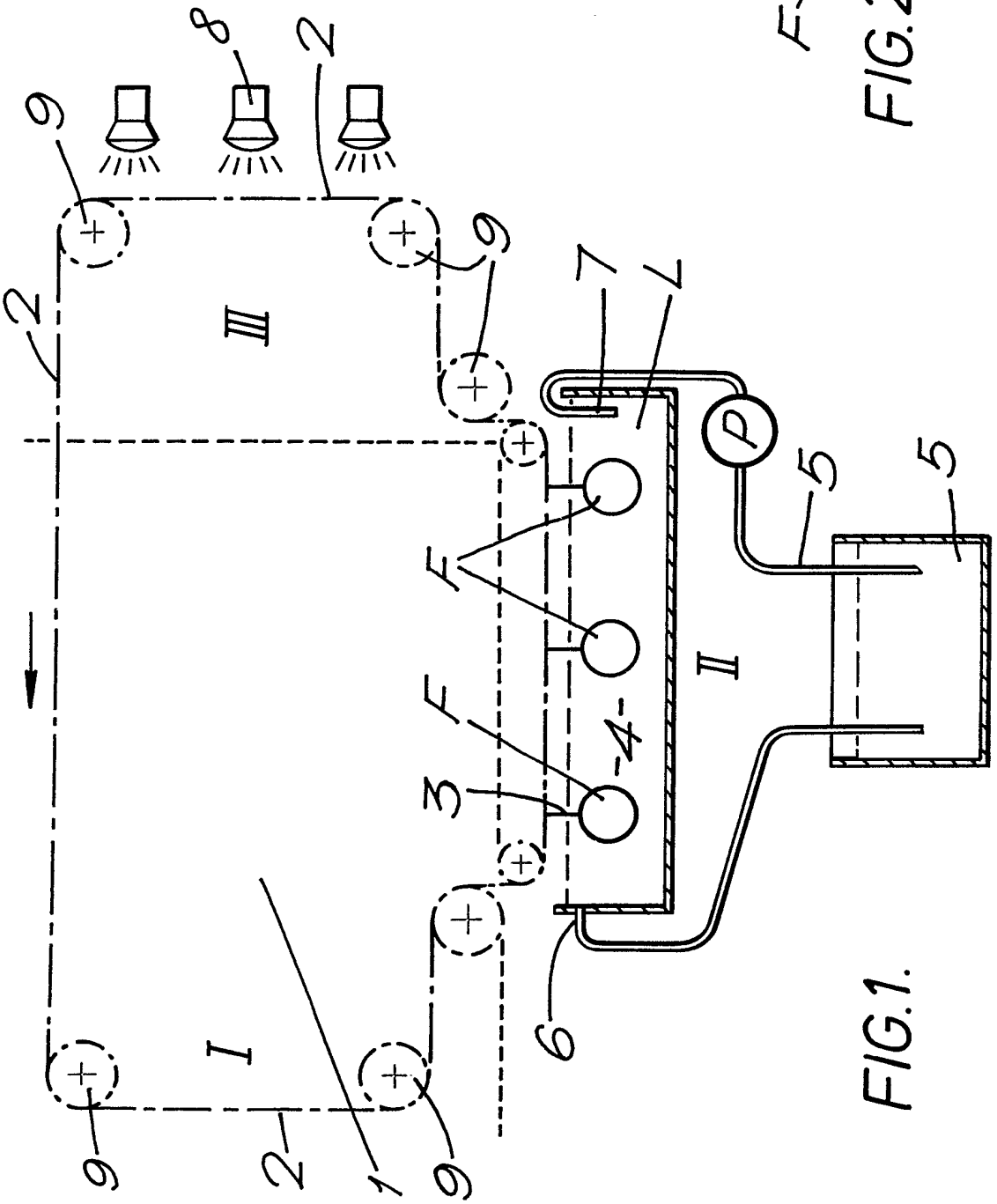

FIG.1.

SPECIFICATION

Compact apparatus for continuous production of a scratch-resistant coating on plastics mouldings

The invention relates to a compact apparatus for the continuous production of a scratch-resistant coating on plastics mouldings. More particularly it relates to the production of scratch-resistant coatings on thermoplastic mouldings, especially transparent or light-reflecting mouldings, using an immersion bath containing a scratch-resistant coating agent and an endless transporting device.

The finishing of surfaces, for example the surfaces of mouldings used for optical purposes (e.g. optical glasses such as spectacle lenses, watch glasses, lenses, prisms, mirrors, scales and also coverings for various purposes) is frequently used in technology. Mouldings consisting of plastics, particularly thermoplastic synthetic materials, already play a considerable part. The plastics used will certainly bear comparison with mineral glass in terms of their optical qualities and even have the advantage as regards their weight, but they are clearly inferior to mineral glass in terms of the delicacy of the surfaces. There has therefore been no shortage of attempts to make the surface of plastics scratch-resistant. Materials which have been proposed as coating materials, depending on compatibility, are hardenable synthetic resins such as polyvinylaldehydes or polvinylesters and a dialdhyde (e.g. US Patent 3 484 157), polyurethanes (e.g. German Offenlegungsschrift 26 11 782), alkyltitanate (e.g. US Patent 3 700 487), melamine in all its different variations, melamine-polyol (e.g. British Patent 1 308 697, US Patent 3 862 261), acrylic resins of all kinds (e.g. German Offenlegungsschrift 23 17 874), fluorinated hydrocarbons in many different combinations and modifications (Netherlands Terinzagelegging 6608 316, German Offenlegungsschrift 19 63 278, German Offenlegungsschrift 24 54 076), cross-linked polyalkyleneimine compounds (US Patent 3 766 299) and silicon compounds particularly silicon resins (e.g. Belgian Patent 821 403, US Patent 3 451 838 and US Patent 3 707 397).

The (liquid) agent for producing the scratch-resistant coating is applied by known methods, e.g. by spreading, spraying, applying with a doctor, applying with a roller or dipping, and the geometry of the mouldings will also play a part in this. The coating of mouldings for optical purposes often imposes high or very high requirements on the coatings, particularly in terms of uniformity, a constant layer thickness and the absence of surface blemishes. At the same time, production on an industrial scale makes it necessary to use machines.

There is, therefore, a need for an apparatus which would enable the continuous production of a scratch-resistant coating on plastics mouldings, particularly the mouldings used for optical purposes and which would satisfy these high requirements.

The demands on coating technology ar numerous and stringent. Thus, the application process should be suitable for application of a conventional (liquid) scratch-resistant coating agent. The process should be as economical as possible, i.e. with the minimum possible waste of coating composition. The quality of the coatings must satisfy the requirements particularly of the optical industry, for example regarding constancy and reproducibility of the layer thickness and absence of blemishes in the coating. On the other hand the applying apparatus should be cheap, uncomplicated and compact. Applicator systems for applying coatings of solids from a liquid phase are known *per se.* They comprise, *inter alia*, an application bath containing the coating composition, as well as suitable transporting means.

We have now devised a compact apparatus which helps overcome these problems.

According to the invention we provide a compact apparatus for the continuous production of a scratch-resistant coating on mouldings, particularly thermoplastic mouldings, which comprises a chamber having at least a first section, a second section and a third section through each of which passes an endless transporting means, said first section containing means both for loading a moulding to be coated and removing said moulding when coated, said second section including an immersion bath adapted in use to contain a liquid coating composition and into which in use said moulding is passed, and said third section including means when in use for drying a coated moulding;

said transport means including in the plane thereof a plurality of elements able to project laterally and retain at least one moulding, the number of retaining elements per unit length of transport means and the speed of movement of the transport means being in use adjustable such that cycle times which correspond to the desired coating and drying times of the moulding are achieved.

Conveniently, the endless transporting means comprises a transporting chain which is guided over corresponding guide elements, e.g. rollers or toothed wheels, at least at the places where a change of direction is envisaged. At at least one point the transporting means is also driven, for example via a pinion/gearwheel which is driven by an engine, the speed of advance being controlled in conventional manner. The design of the equipment as a compact apparatus demands that the apparatus keep within certain dimensions. For example, the length should desirably be approximately 2.5 m, the height about 1 m and the width of the apparatus about 0.5 m. It is preferable to use transparent materials such as, for example, acrylic glass for lining the walls. The drying means appropriately comprises a suitable heat source, e.g. at least one, preferably two or more infra-red radiators of suitable power. Preferably, a cleansing bath may also be provided upstream of the immersion bath. The cleansing bath may, for example, be an ultrasonic bath containing organic solvent.

When in use, the immersion bath contains the scratch-resistant coating composition. Conveni-

ently, the transporting means is screened, at least in the region of the immersion bath so that no impurities etiher carried along or formed *in situ* can get into the immersion bath. This may be achieved, for example, by mounting a trough below the transporting means or by providing a tunnel-shaped lining in the section through which the transporting means is guided, with a slot provided for the retaining elements to pass through. Preferably, the immersion bath is designed so that its temperatures can be regulated.

This invention permits the use of a broad range of (liquid) scratch-resistant coating compositions known *per se* (see for instance the prior art referred to above). The method of operation of the apparatus, particularly its cycle times, may be matched to the characteristics of the scratch-resistant coating composition used.

The known scratch-resistant coating compositions based on silicon resin are particularly suitable. Very good results have been obtained, for example, with scratch-resistant coating systems according to DE-OS 31 44 777 and DE-OS 31 35 241. By adjusting, for example, the viscosity of the coating composition on the one hand and the speed of the transporting means on the other hand, it is possible to obtain a scratch-resistant coating which is satisfactory in every respect. As a guide for practicable times, between $\frac{3}{4}$ and $1\frac{1}{4}$ hours for one loading, coating, drying and unloading cycle would be appropriate.

The plastics mouldings are preferably produced from thermoplastic material (for a definition of this see DIN 7724), particularly from polyolefins and polyvinyl compounds and copolymers such as ABS and SAN, polyamides, polyacetals, polycarbonates, polyesters and to some extent polyurethanes, which are generally processed by extrusion or injection moulding (of Angew. Chemie, 86, (1974) No. 9, p. 24-36). Particular mention should be made of acrylic resins, particularly those based on polymethylmethacrylate and polycarbonates.

In the interests of the least possible contamination, it may be appropriate to carry out the coating of the mouldings immediately after they themselves are produced, for example by arranging the present compact apparatus immediately downstream of an injection moulding apparatus, preferably with the ejector of the injection moulding machine and the receiver of the compact apparatus being located in a dust-free chamber. Contamination may also be prevented to some extent by providing the apparatus with a lining which is as dust proof as possible, so as to form a sealed chamber, with the exception of the first section. It may be desirable to force a dust-free protective gas, e.g. air, into the apparatus while it is in operation. The mouldings are scarcely limited at all in terms of their geometry, which must count as another advantage of the present invention.

It is particularly useful to apply this invention to the mouldings for optical purposes specified hereinbefore, such as optical glasses, e.g. spectacle lenses, watch glasses, lenses, mirrors, scales, etc;

The apparatus may be represented schematically by the accompanying drawings, which are by way of example only.

Figure 1 shows in outline a compact apparatus of the invention.

Figure 2 shows a moulding to be coated using the apparatus of the invention.

In Figure 1, an apparatus 1 has a first section I, a second section II and a third section III. Through each of these passes a transporting means in the form of an endless conveyor belt 2. The conveyor belt 2 has a plurality of retaining elements 3 which either pick up or onto which are loaded in the first section I mouldings F to be coated. Arrows indicate the direction of travel of the belt 2.

The mouldings are, in the second section II, immmersed in an immersion bath 4 containing liquid coating which when dried will be scratch-resistant. The bath is provided with an outlet aperture 6 and an inlet 7 for a filter circuit 5, this being means for introducing liquid coating into the bath and keeping it topped up. Additionally, L represents coating lacquer which when dried is scratch-resistant, and P represents a pump.

After immersion, the conveyor belt transports coated mouldings to the third section III where they are dried by sources of heat 8. Throughout all these operations, the conveyor belt is guided by guiding elements 9.

The coated mouldings, thus dried, then return to the first section I for unloading and the cycle starts again.

In the production of mouldings which will finally be round or oval, mostly planar, such as spectacle lenses, watch glasses and so on, the moulding may be shaped as shown in Figure 2. In Figure 2, a moulding is shown in which a lug 10 for clamping purposes is formed thereon and diametrically opposite this lug 10 is a drip-off lug 11 so that the excess scratch-resistant coating composition can drip off without forming a ridge when coated and dried. The two elements 10 and 11 can be removed in known manner, for example by mechanical means, at a convenient time later on. The retaining elements 3 serve to clamp the mouldings F as securely as possible and without causing any damage to them so as to enable the coating process to be carried out fully, using known fixing means, e.g. by cramping or clamping by means of pins and corresponding openings in the mouldings. The retaining elements 3 conveniently comprise a pin on which a matching sleeve is removably fitted, this sleeve bearing elements for fixing the mouldings F. The number of these elements may be from 1 up to 8, for example, or 6 in the case of spectacle lenses.

As already mentioned, this compact apparatus is particularly suitable for satisfying the many technological requirements for a continuously operating means for producing a scratch-resistant coating on mouldings.

CLAIMS

1. A compact apparatus for the continuous production of a scratch-resistant coating on mould-

ings, particularly thermoplastic mouldings, which comprises a chamber having at least a first section, a second section and a third section through each of which passes an endless transporting means, said first section containing means both for loading a moulding to be coated and removing said moulding when coated, said second section including an immersion bath adapted in use to contain a liquid coating composition and into which in use said moulding is passed, and said third section including means when in use for drying a coated moulding;

said transport means including in the plane thereof a plurality of elements able to project laterally and retain at least one moulding, the number of retaining elements per unit length of transport means and the speed of movement of the transport means being in use adjustable such that cycle times which correspond to the desired coating and drying times of the moulding are achieved.

2. Apparatus as claimed in claim 1, wherein the endless transporting means is a transporting chain which abuts on guide elements at least at the places where a change of direction is envisaged.

3. Apparatus as claimed in claim 1 or claim 2, wherein a cleansing bath is provided upstream of the immersion bath.

4. Apparatus as claimed in claim 3, wherein the cleansing bath comprises an ultransonic bath containing organic solvent.

5. Apparatus as claimed in any of claims 1 to 4 wherein the retaining elements projecting laterally from the transporting means in the plane of the belt comprise a pin with a sleeve removably placed thereon, this sleeve having fixing elements for the thermoplastic mouldings.

6. A compact apparatus for continuous production of a scratch-resistant coating on a moulding substantially as herein described.

7. Apparatus substantially as hereinbefore described and with reference to the accompanying drawings.

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